PRELIMINARY ESTIMATES OF COSTS AND BENEFITS OF ALTERNATIVE SOLUTIONS FOR FLOOD DAMAGE REDUCTION

REPAUPO CREEK WATERSHED
GLOUCESTER COUNTY, NEW JERSEY

APRIL 1996

USDA NATURAL RESOURCES CONSERVATION SERVICE
IN COOPERATION WITH GLOUCESTER COUNTY SOIL CONSERVATION DISTRICT

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CONTENTS

Introduction

The initial request for assistance for replacement of the existing tidegate structure was made by Greenwich Township and Gloucester County to the Natural Resources Conservation Service (then the Soil Conservation Service) in April 1994. Interdisciplinary team reviews were made in May and August 1994. Greenwich Township, through the South Jersey Resource Conservation and Development Council, made a formal request for technical and cost share assistance under the PL-566 (Watershed Protection and Flood Prevention Act) Program in December 1994. A commitment was made to a Greenwich Township official for this report in October 1995.

Purpose

The purpose of this report is threefold: to review available data pertinent to the Repaupo Creek watershed and, where possible, provide preliminary estimates of the costs and benefits of several alternatives for flood prevention; to consider environmental and cultural resource concerns related to each alternative in the Repaupo Creek watershed and to provide sponsors with identification of potential funding sources. The data gathered for this report will provide the basis for evaluating whether there is sufficient justification for supplementing the existing PL-566 Repaupo Creek Work Plan completed in November 1962.

Limits to this Report

-Geologic data collection for the existing levee system could not be performed. Corps of Engineer files were to be reviewed but could not forwarded.

-The accuracy of estimates for potentially damaged properties and estimated benefits were limited due to lack of adequate 1-2 foot contour interval maps. One possible method for developing a benefit-cost analysis is through the use of geographic information system (GIS) technology. As a result, no cost estimate for Alternative 5 and 6 could be developed.

History & Environmental Setting

The 13,000-acre Repaupo Creek watershed outlets into the Delaware River opposite Chester, Pennsylvania. Figure 1 shows the watershed and its location. The watershed is identified as Hydrologic Unit Code 02040202140 in the National Hydrologic Unit Code System. Statewide, the south central Delaware River tributaries including the Repaupo Creek watershed are identified as a medium priority hydrologic unit (40th of 107 hydrologic units) in terms of their need for detailed flood control planning (Anderson-Nichols & Co, Inc., 1985). Ranking was based on, among others, the number of damaging storms reported during the period of record, total dollar damages reported for all storms, number of residences in the 100 year floodplain, number of small businesses or other structures in the 100-year floodplain, residential population of the 100-year floodplain; and number of federal, state, county and local roads overtopped by the 100-year flood.

Greenwich Township, New Jersey lies on the east side of the Delaware River just south of Philadelphia International Airport. Gibbstown is the largest community in the Township. This community was settled in the 1700s and has a history of flood damages caused by the Delaware River and its tidal fluctuations. The Repaupo Meadow Company was incorporated through an Act of the State Legislature passed on November 28, 1831 and a Supplementary Act approved on March 10, 1886. Its purpose was to establish and maintain a levee and tidegate system to protect lowlying areas from tidal and storm related flooding from the Delaware River. The original purpose was to protect agricultural land from flooding; however, today it largely protects residential, commercial, industrial and transportation land from flooding. The levee is approximately 4.5 miles long and has 16 operable gates at six locations. These consist of three 42-inch circular flapgates at Clonmell Creek; three 42-inch circular flapgates near Crab Point; one 42 inch square gate near Socony Vacuum Plant; four 30-inch square gates at Sand Ditch; two rectangular wooden gates, 11.5 feet by 3 feet high, at Repaupo Creek; and the 1964 constructed tidegate at White Sluice Race consisting of three rectangular wooden gates 58 by 88 inches.

The most severe storms in the Delaware River Basin occur when a hurricane is moving up the Atlantic Coast or joins an extra-tropical storm resulting in a combined effect. The November 25, 1950 storm produced 3.46 inches of rain at Philadelphia in a 16 hour period with a near record tide of 8.6 feet m.s.l. Hurricanes Connie and Diane resulted in the tidal stage of the Delaware River reaching 8.0 and 7.8 m.s.l. over the August 11-14th period and on August 20th, respectively. These storms produced 5.5 and 3.0 inches of rainfall, respectively. The March 6-7, 1962 storm which produced a maximum

tide stage of 7.2 feet m.s.l., resulted in breaching of the levee at three locations. Prior to the 1962 restoration work, an agreement was reached between the Soil Conservation Service and the Corps of Engineers to coordinate efforts here. The Corps was to restore the levee to its pre-storm condition (and thereafter give consideration to modifying the structure under regular flood control authorities delegated to the Chief of Engineers) and the Soil Conservation Service was to provide interior land drainage measures, including a tidegate structure, and construct the necessary drainage under Public Law 566. This agreement, to the extent of our knowledge, continues to remain in effect.

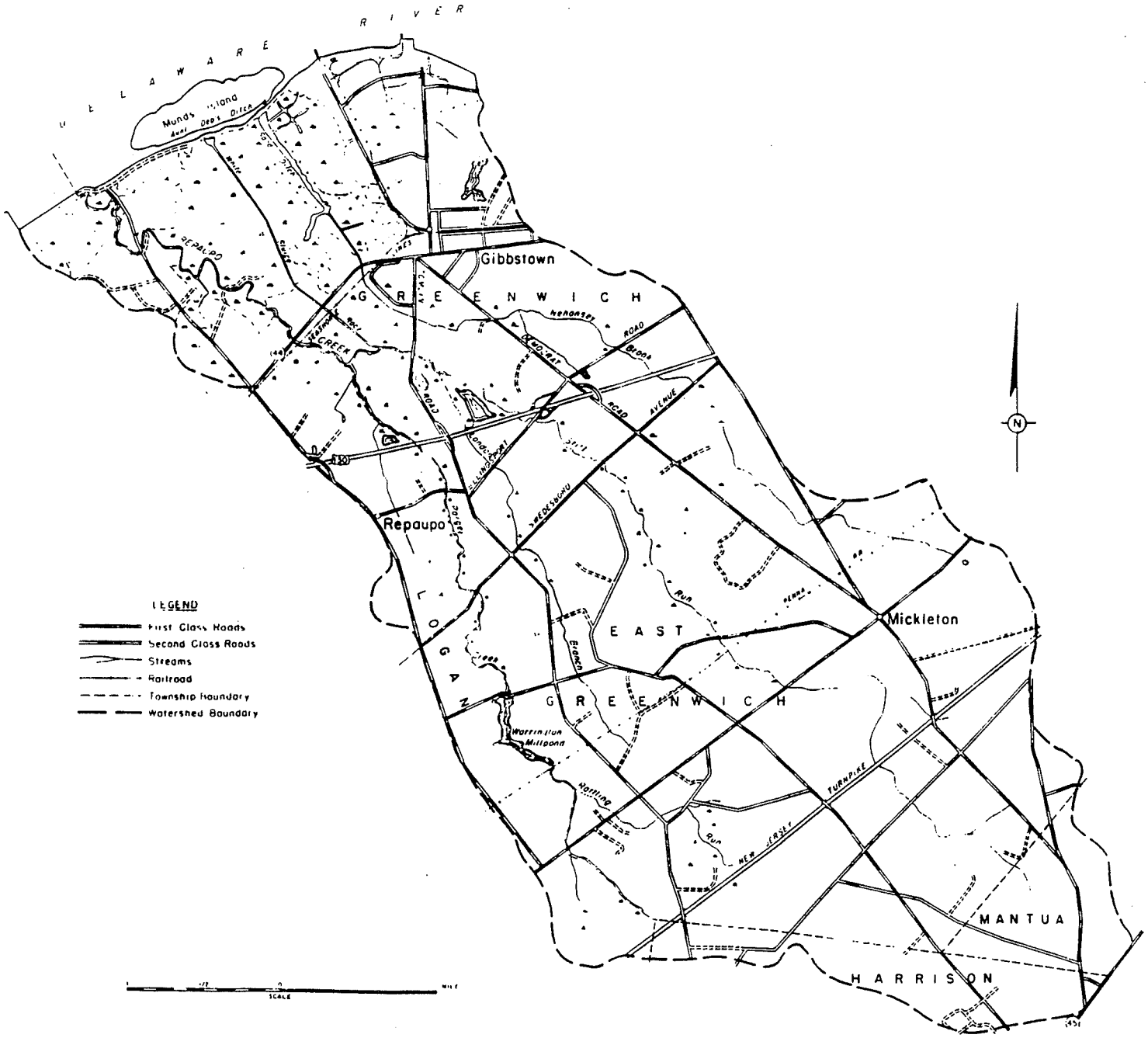
The levee damage was repaired by the Corps of Engineers to pre-storm conditions under authority of Public Law 99/84 in 1962. This program provided an interim measure that protects against a flood having a recurrence interval of once in 14 years. The 1967 Corps study recommended raising and reinforcing the levee for 100 year protection; however, the study was halted in March 1970 due to lack of local funds from the Repaupo Meadow Company (Callegari, 1994). In April 1973, the Repaupo Meadow Company formally requested the Corps to reactivate the study. The study was again reactivated but was again terminated in December 1976 when no written assurances of local cooperation were furnished (Callegari, 1994).

The Soil Conservation Service completed installation of White Sluice tidegate structure and approximately 12 miles of channel improvement (USDA, 1962). Although all measures detailed in the work plan have been installed, the project was never formally closed. An operation and maintenance agreement between the Service and the Repaupo Meadow Company signed in June, 1963 remains in effect.

U.S. Coast and Geodetic Survey tide records show extreme tide levels at Philadelphia to be 9.0 feet below and 8.8 feet above sea level datum on December 31, 1962 and August 24, 1933, respectively. The mean high water stage is elevation 3.7 feet and the mean low water stage is -2.3 feet mean sea level.

Greenwich Township is one of six municipalities in the watershed. Municipalities and their estimated population in the watershed are shown in Table 1.

Figure 1
Watershed Map



Scale 1" = 5280 feet

Table 1
Watershed Population

Municipalities	Population (1990)
East Greenwich Township	3,041
Greenwich Township	2,797
Harrison Township	400
Logan Township	287
Mantua Township	123
Woolwich Township	52
TOTAL	6,700

Source: History of the Repaupo Creek Watershed Project, Gloucester County Planning Department (1990)

Soils

Upland soils consist largely of the Freehold, Sassafras, Marlton and Woodstown series. These are high quality agricultural soils that are categorized as either Prime or of Statewide Importance. Wetland soils are mapped as Tidal Marsh.

Land Use

Land uses within the watershed are shown in Table 2. This area also includes a Superfund Site, municipal landfill, co-generation plant and railroad facilities.

The Repaupo Creek watershed (Figure 1) is primarily agricultural, with approximately 6,309 acres (Gloucester County Planning Department, 1990) in active productive farmland. The most prevalent crop appears to be soybeans, with some fall-planted small grains also important. Other annual crops that are grown in the watershed are vegetables and lesser amounts of both silage and grain corn. Orchards are scattered around the watershed. Hay and pastures are not an important land use. The next largest category of land use is the 2,720 acres of wetland.

Table 2
Watershed Land Use

Land Use	Acres*
Agriculture	6,309
Wetland	2,720
Wooded	1,315
Single Family Residential	1,068
Multi-Family Residential	13
Transportation	430
Industrial	143
Commercial	52
Public	117
Recreational	26
Vacant	495
Water Body	312

Source: Gloucester County Planning Department, 1990 data.
* Adjusted to 13,000 acre watershed

Problem Description

A Greenwich Township official has identified two major concerns or objectives. They are as follows:

1. Flood protection from Delaware River

2. Flood protection from Repaupo Creek

Other problems such as agricultural water conservation, water quality, soil erosion, and other resource issues may exist in the watershed. Some agriculturally related concerns have been identified and will be discussed later in this report. The local people have been encouraged to form a broad-based steering committee to involve all stakeholders in the watershed so that all significant problems are addressed and opportunities enhanced for funding from government and private and nonprofit sources.

The current problem is a failing tidegate structure, built circa 1919, at the mouth of Repaupo Creek at the Delaware River. In addition, the existing levee, based on the U.S. Army Corps 1967 Report, provides protection against a flood having a recurrence interval of once in fourteen (14) years.

Ownership of the tidegates and levee system is currently in question. Recent correspondence (Cubberly, 1995) indicates that the State Bureau of Tidelands Management does not believe that the State owns this area and is not financially responsible for repairs. According to survey records (Carter, 1963), the Repaupo Meadow Company owns the levee and the Repaupo and White Sluice structures. The Repaupo Meadow Company (according to the operation and maintenance agreement (Bennett, 1963) for the Repaupo Creek Watershed Soil Conservation Service-assisted works of improvement completed during the 1960s) is the party ultimately responsible for their maintenance. Repaupo Meadow Company has not had any financial resources since 1993 (Langley, 1995).

Water Quality Needs

According to the State Water Quality Inventory Report, Repaupo Creek fully sustains the aquatic life support designated use and has a healthy warm water fishery. There are some documented ground water quality problems in the lower reaches of the Repaupo Creek watershed. Several common agricultural pesticides have been detected in the vicinity (Lewis, et al, 1991) but it is unclear whether these well sites are in the Repaupo watershed.

There is very little Highly Erodible Land in the watershed, with 244 acres (Lee, 1996) currently carrying that designation. The slopes are less than 5 percent in most fields and serious erosion problems are not evident. In late January 1996, following weather events of excessive moisture and runoff, only a few instances of ephemeral gully erosion were observed in the upper reaches of the Rattling Run and Still Run tributaries.

Erosion hazards that may exist should be effectively treated with agronomic, non-structural alternatives such as conservation crop rotation, cross-slope farming, seasonal residue use, cover cropping, vegetative filter strips, and residue-conserving tillage practices. It also should be noted that in most areas, surface waters are separated from cropland by riparian forested buffers consisting primarily of deciduous trees, shrubs, and herbaceous forbs, grasses and vines.

Animal waste pollution does not appear to be a critical issue, as livestock-based operations are few and far between. However, potential may exist for fertilizer phosphorus loading to surface waters and nitrate leaching to ground water simply due to the large acreage of annually planted cropland. Regular soil testing and comprehensive nutrient management planning should eliminate this potential pollution concern. Technical assistance for these practices is available through the Gloucester County Soil Conservation District and Rutgers Cooperative Extension of Gloucester County.

The large acreage of croplands and orchards could mean that the potential exists for pesticide pollution. Local growers should, if not doing so, participate in the Rutgers Integrated Pest Management (IPM) program.

Approximately 45 percent of the 66,000 cropland acres in Gloucester County are irrigated (Rutgers, 1996). Irrigation Water Management (IWM) is an important issue on the 700 acres of vegetables and orchards. However, these crops are not dominant in the basin compared to the cash grain acreage.

Estimated Flood Damage

The 1962 storm resulted in damages to 407 acres of cropland, 103 acres of woodland and 97 acres of urban property (USDA, 1962). Table 3 shows the number of Federal flood insurance policies in place in 1994 and the 1996 Resources Conservation Act (RCA) Appraisal estimate of average annual flood damages for each watershed municipality. There were 251 flood insurance policies paying $84,577 in annual premiums covering $16,840,000 in property values in Greenwich Township as of June 30, 1995 (Gilman, 1996). Since the inception of the National Flood Insurance Program in 1978, there have been 14 claims, none of which were a repetitive loss, for damages totaling $13,051 (Gilman, 1996). This information, however, is not necessarily specific to the Repaupo Creek watershed.

Table 3
Extent of Estimated Damages

Municipalities	Flood Insurance Policies	Estimated Average Annual Flood Damages	
		Residential	Other
East Greenwich Township	18	$76,287	$39,003
Greenwich Township	256	$461,113	$235,749
Harrison Township	4	$16,953	$8,667
Logan Township	32	$57,639	$29,469
Mantua Township	12	$50,858	$26,002
Woolwich	2	$8,476	$4,334

Sources: Federal Emergency Management Agency. January 31, 1994. WYO and Direct Data by Community with County and State. Only Communities with Insurance Data. Flood Insurance Policies.

U.S.D.A. Natural Resources Conservation Service. 1996 Resources Conservation Act Appraisal (Draft). 1994 Price Base.

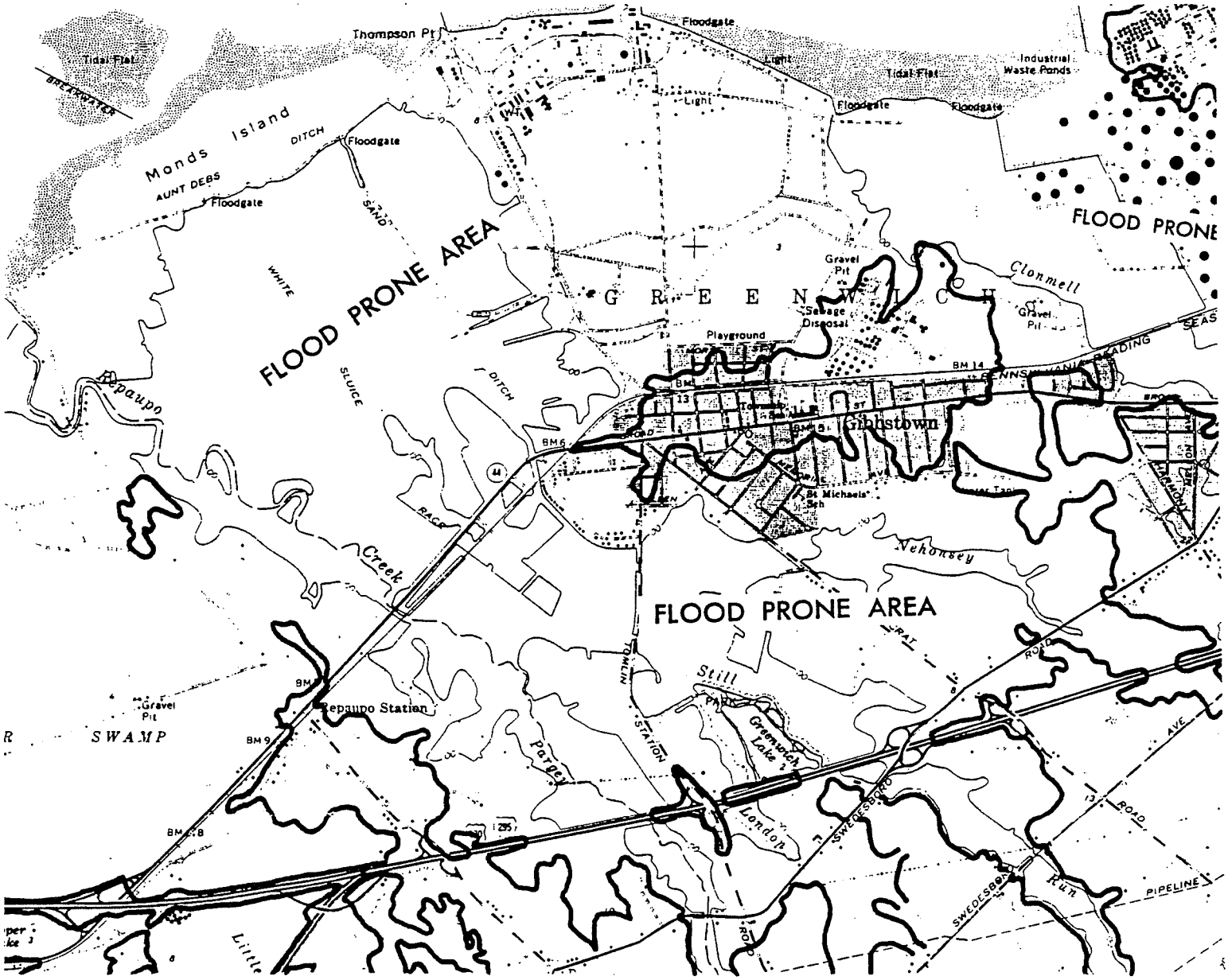
The Community Rating System of the National Flood Insurance Program offers eighteen (18) creditable activities to communities to reach three goals, namely, reduce flood losses, facilitate accurate insurance rating and promote awareness of flood insurance. Benefits of these activities include reduced flood insurance rates, increased public safety, reduction of damages to property and public infrastructure, avoidance of economic disruption and losses, reduction of human suffering and protection of the environment (FEMA, 1990). Some of these creditable activities include advice to potential purchasers and residents of flood-prone property about the flood hazard, flood insurance, and flood protection measures, maintainance and publicizing a library of references on flood insurance and flood protection, open space preservation, purchase or relocation of buildings and conversion of flood-prone properties to open space. Greenwich Township, while participating in the National Flood Insurance Program, does not currently participate in the Community Rating System (Gilman, 1996).

The 1967 US Army Corps Report showed that 65 residents and business establishments in and around Gibbstown were flooded during the 1962 breach of the levee. The March 6-7, 1962 storm produced a maximum tidal stage of 7.2 feet m.s.l. at Gibbstown (US Army Corps, 1967). Tidal records between 1922 and 1967 show that this stage has been equaled or exceeded at least eight times. Between 1967 and 1991 there were seven years when there was at least one event where the tide exceeded 7.0 feet m.s.l. at the nearby Philadelphia tide gage (Gebert, 1996). The highest tides of record (8.5 feet m.s.l.) since 1922 occurred in August 1933 and November 1950.

It was not possible to identify specific properties which would be affected under different levels of inundation (5, 10, 25, 50 and 100 year) due to the lack of adequate topographic information at the one foot contour interval. Information, however, was obtained from several other sources to describe the general nature of the problem. Approximately 215 properties were estimated to be affected in Greenwich Township (Gibbstown) by the maximum high tide of record (8.5 ft. m.s.l.) during planning for the White Sluice tidegate project (SCS, 1962). An estimated 197 of these properties were estimated to have at least one foot of flooding on the first floor.

Figure 2 shows those areas which are subject to the 100 year flood (10 feet m.s.l.) as defined by the Federal Emergency Management Agency. Since 1962, the number of affected properties nearly doubled. A review of aerial photography and topographic maps since then shows that there has been considerable development in the flood prone area. An analysis of those properties affected by the 100 year flood shows that over 400 homes, churches and businesses would be impacted in the Greenwich Township area alone.

Figure 2
Flood Prone Area Map



Scale 1" = 1560 feet

Estimated Costs of Alternatives

The location of the various alternatives is shown in Figure 3.

Alternative 1 - Enhance Existing Levee - The current levee has a 14 year storm level of protection. A reconnaissance study was performed by the Corps of Engineers in 1967 (US Army Corps of Engineers, 1967). A cost estimate was developed for this alternative using the Corps 1967 estimate of $730,000. An index was developed using a well known source (Smit, 1996) to update the Corps estimate to 1996. The estimated cost for this alternative is $2.7 million. It should be noted that this alternative is under US Army Corps of Engineers jurisdiction.

Alternative 2 - Replace Existing Repaupo Creek Tidegate Structure This alternative would involve maintaining the existing condition by replacement of the failing circa 1919 structure. All residential, commercial and transportation corridor properties would remain protected to the 14 year storm level of the existing levee.

The cost estimate for this alternative is based upon replacement of the existing tidegate structure with a structure similar to the White Sluice Race structure installed by the Soil Conservation Service in 1965. The White Sluice Race structure is essentially a reinforced concrete rectangular section with 45 degree wingwalls at the corners and three (3) 4 ft. x 7 ft. flap gates. The 1965 construction cost was $169,880. This estimate was updated to 1996 by developing an index (Smit, 1996). The cost estimate for this alternative is $1.5 million.

Alternative 3 - Rebuild Levee and Tidegate at its Existing Location or Directly Behind the Existing One - The cost of this alternative was based upon a levee length of 22,722 feet (US Army Corps of Engineers, 1967). A typical cross-section of levee was used to calculate the estimated volume of earthfill which amounts to 655,600 cy. The estimated 18" diameter rock riprap and filter fabric to be used to protect against wave activity was based on another project done by the Natural Resources Conservation Service. The costs per unit quantity were developed from current projects or Smit, 1996. The cost estimate for this alternative is $26.5 million. It should be noted that the levee portion of this alternative is under US Army Corps of Engineers jurisdiction.

Alternative 4 - Levee Enhancement and Replacement of Repaupo Creek Tidegate Structure - Combine Alternative 1 and 2. The estimated cost of this alternative is $4.2 million.

Alternative 5 - Relocation of Levee and Tidegate System to Route 44 - This alternative would involve the replacement of the existing 4.5 mile long levee and tidegates at three locations (including the White Sluice Creek structure installed by SCS in 1964) by an approximately 8400 foot long levee with two (2) tidegate system along the Route 44 corridor. Approximately a dozen residential dwellings along Floodgate Road would be subject to flooding and would need to purchased. Also, a racetrack and a Green Acres-purchased Township Park adjacent to the existing levee would also be affected. An analysis of the owners of record in the vicinity between Route 44 and the Delaware River is shown in Table 4. It should be noted that the three major landowners own approximately 94 percent of the approximately 1800 acres here with Dupont Company and Greenwich Township owning 85.4 and 6.5 percent, respectively of the overall acreage. Also, the existing 32 year old White Sluice tidegate structure, financed in part with PL566 funds, would be rendered unnecessary. The bulk of residential, commercial and transportation corridors would be protected from the 100 year flood. Tidal wetlands would be restored.

An estimated cost for this alternative was not developed due to a lack of data. Data required include field survey data (channel and/or valley cross-sections); structure information tied to field surveys; one foot contour interval map, land cover and soils. These data would be required to determine the effects of relocating the existing levee and structures to Route 44. The hydrology and hydraulics analysis would include evaluation of the capability of the area upstream of Route 44 to store upstream floodwaters.

It should be noted that the levee portion of this alternative is under Corps of Engineers jurisdiction. Also, Route 44 would be under the New Jersey Department of Transportation jurisdiction.

Table 4
Analysis of Property Ownership Between
Route 44 and Delaware River in Repaupo Creek Vicinity

Owner	Number Parcels	Acres
E.I. DuPont de Nemours Company	14	1560
Greenwich Township (includes Green Acres tract)	20	118
American Dredging Company	3	14
Atlantic City Electric Company	3	39
Other	24	94

Source: Greenwich Township 1995 Tax Maps

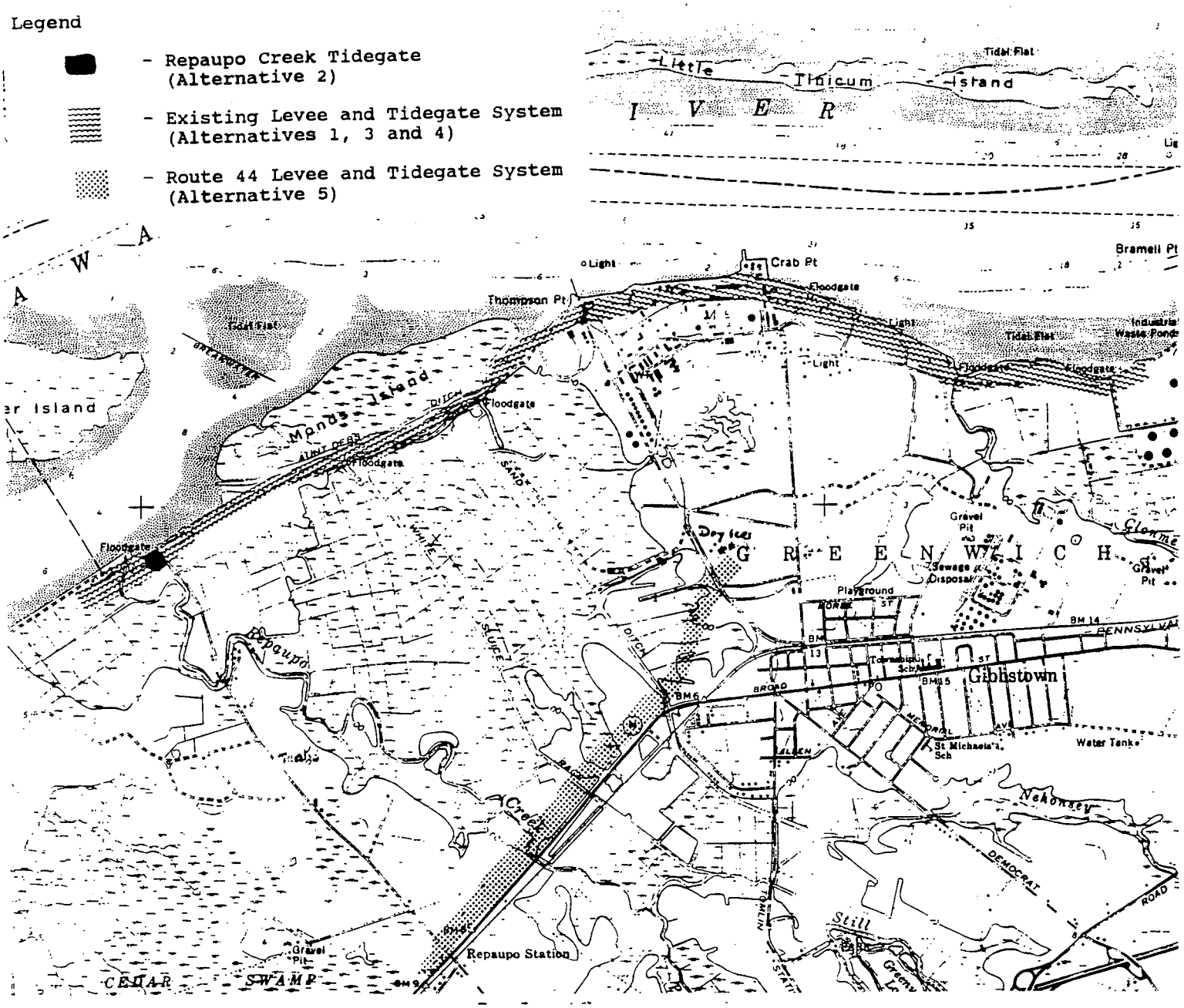
Alternative 6 - Total Buyout - This alternative would involve the purchase of over 400 residential, commercial and transportation corridor properties in the 100 year flood plain as defined by the Federal Emergency Management Agency.

Alternative 7 - No Action - This alternative would involve no change.

Potential Funding Sources

Potential funding sources for several alternatives, in addition to the local sponsors, may include the Natural Resources Conservation Service PL-566 (Watershed Protection and Flood Prevention Act) and Wetland Reserve Programs, New Jersey Wastewater Treatment Trust Fund, U.S. Fish and Wildlife Service Partners for Wildlife, North American Wetlands Conservation Act and Endangered Species Recovery Fund Programs, New Jersey DEP Wetland Mitigation Council Program, New Jersey Fish, Game and Wildlife Wetland Purchase Program, Ducks Unlimited, Public Service Electric and Gas Company, New Jersey Department of Transportation, DuPont Company, and Coastal America.

Figure 3
Location of Alternative Solutions
for Flood Protection



Scale 1" = 1560 feet

Table 5

Features and Estimated Construction Costs of Alternatives

Alternative	Features	Construction Cost
1	Levee Enhancement (22,722 Ft)	$2,700,000.
2	Tidegate Structure (1)	$1,500,000.
3	Levee Reconstruction (22,722 Ft.) Tidegate Structure (1)	$26,500,000.
4	Levee Enhancement (22,722 Ft.) Tidegate Structure (1)	$4,200,000.
5	Levee Construction (8,400 Ft.) Tidegate Structures (2) (Route 44 Corridor)	ND
6	Buyout (Purchase of floodprone properties)	ND
7	No Action	-0-

ND - Insufficient data

Environmental Evaluation - Groundwater

The Potomac-Raritan-Magothy aquifer system underlies the Merchantville-Woodbury confining unit. The system consists of three aquifers - upper, middle, and lower, and two confining units (Barton and Kozinski, 1991). Before development of the area, ground water flow patterns within the Potomac-Raritan-Magothy aquifer system were controlled by natural hydraulic gradients. These gradients reflected the difference in elevation and distance between recharge and discharge areas (Barton et al., 1991). The main source of recharge to the system was precipitation on high altitude areas of the outcrop northeast of the Greenwich Township region (Hardt et al., 1969 and Barksdale, et al., 1958). In the Greenwich Township region, ground water discharged into the Delaware River (Barksdale, et al, 1958; Hardt, et al, 1969 and Gill and Farlekas, 1976).

After development, extensive pumping of ground water from the Potomac-Raritan-Magothy aquifer system in eastern Gloucester, northern Camden, and western Burlington Counties decreased potentiometric levels in both the unconfined (Paulachok and Wood, 1984) and confined parts of the aquifer system (Eckel and Walker, 1986). This lowering of water levels resulted in a reversal of ground water gradients throughout much of the aquifer system. Water from the Delaware River now recharges the aquifer system, and water from the confined part of the Potomac-Raritan-Magothy aquifer system is transmitted downdip into the confined parts of the system (Barton, et al., 1991). In the Greenwich Township region subsurface flow within the confined aquifers is generally east-southeastward toward a large regional cone of depression centered in the areas of pumping in and near Camden County (Eckel, et al., 1986). The Greenwich Township region lies within the northwestern part of this cone of depression (Barton, et al., 1991).

Vertical hydraulic gradients in the subcropping and shallow downdip parts of the aquifer suggest a potential for water to move from the Delaware River into the aquifer system and downward through leaky confining units to underlying aquifers. In deeper, confined parts of the aquifer system in the southeastern part of the region, vertical hydraulic gradients between aquifers are reversed, resulting in a potential for water to move into the upper aquifer (Barton, et al., 1991). Additionally, the confining layers separating the upper, middle and lower aquifers are discontinuous or lens-like in this region (Barton, et al., 1991).

In 1986, withdrawals from the Potomac-Raritan-Magothy aquifer system (and the overlying, hydraulically connected Upper Cenozoic deposits) constituted more than 99% of the total reported ground water withdrawals in the Greenwich Township region. By 1986,

withdrawals were approximately evenly distributed among the three aquifers (Barton, et al., 1991).

The delineations discussed above are made to describe which aquifer within the Potomac-Raritan-Magothy aquifer system wells of varying depths pump from. For our purposes, however, because of the discontinuity of confining layers and the changes in vertical gradients, the Potomac-Raritan-Magothy aquifer system will be considered one unit.

Outcrops and subcrops of the Potomac-Raritan-Magothy aquifer system essentially parallel the Delaware River throughout the study area (Barton, et al., 1991).

The long-term mean annual invasion point of saline water in the Delaware River is within the Greenwich Township region at Chester, Pennsylvania (Anderson, et al., 1972). However, when freshwater flow is very low, as it was during the 1961-66 drought, saltwater may advance into the estuary as far north as Philadelphia (Barton, et al., 1991).

Alternative 5 will accelerate recharge by the Delaware River of the middle aquifer when the saltwater-freshwater interface has migrated upstream into the study area. While no alternative has any impact on the migration of saline water in the Delaware River, Alternative 5 would increase the amount of saline water entering the middle aquifer when the saltwater-freshwater interface has migrated upstream into the study area. Another study done in 1991 near Logan Township shows induced recharge of the Potomac-Raritan-Magothy aquifer system by the Delaware River to be less influential than precipitation, due to thicker clay and silt-rich Upper Cenozoic deposits that separate the river from the aquifers (Lewis, et al., 1991). The recharge from the marsh on the lower reach of Repaupo Creek may only comprise a small portion of the total recharge to the wells and there may be a lag time, which could be on the order of years, between the occurrence of the saltwater encroachment event and the breakthrough of saltwater at the wells (Navoy, 1996).

Alternatives 6 and 7, which are the total buyout and no action options, respectively, would ultimately result in the failure of the existing levee and tidegate system with saltwater encroachment of not only the marsh area between Route 44 and the Delaware River but also areas to the head of tide upstream of Route 44.

Environmental Evaluation - Fish, Wildlife and Vegetation

The levee system at the confluence of Repaupo Creek and the Delaware River has been in place over 150 years for flood control and to increase agriculturally productive land.

Most of the former agricultural land near the Delaware River was abandoned long ago and has reverted to emergent, scrub shrub or wooded wetland. This area was once subject to daily tidal flooding from the Delaware River but since levee construction in the early 1800's daily tidal flooding has not occurred. Considerable areas are overgrown with Phragmites australia and Lythrum salicaria, two invasive, exotic weed species.

Table 6 lists dominant species of vegetation present in the wetlands between Route 44 and the Delaware River levee found during investigations completed in February 1996. Table 7 lists threatened and endangered species of wildlife and their specific habitat type known to occur in the Repaupo Creek vicinity.

Zich (1977) reports that through historical literature search, personal interviews and field investigations, Repaupo Creek once had Clupeid spawning runs of American shad and herring. These runs are assumed to have become extinct at the time of construction of the first tidegate at the confluence of the Delaware River and Repaupo Creek.

For six of the seven alternatives, a brief discussion on impacts to wetlands, vegetation, fisheries and wildlife is presented. A more detailed analysis will be needed in the future. This is meant to be a preliminary investigation for the early planning stages of the potential project.

Alternative 1 - Enhance Existing Levee

This alternative would increase the size of the existing levee. Some of the wetlands would be filled to expedite the footprint of the levee. Exact wetland acreage lost cannot be determined until engineering plans are completed. There would be a loss of existing wetland vegetation and wildlife habitat where this fill occurs. Other impacts to local fisheries and wildlife would be temporary in nature during the construction phase of the project. There would be no significant changes to the 1,000 acre wetland between Route 44 and the Delaware River.

The impact of the small amount of wetland lost to fill along the levee could be mitigated by wetland restoration in the Repaupo watershed upstream. Construction could be scheduled to reduce the temporary impacts to fish and wildlife. Critical breeding/nesting/spawning seasons should be avoided.

Table 6
Dominant Plant Species in Wetlands Near
Repaupo Creek, Gloucester County, New Jersey

Species	Common Name
Emergent Wetland Behind Levee	
Phragmites australis	Phragmites
Typha latifolia	Broad-leaved cattail
Typha angustifolia	Narrow-leaved cattail
Hibiscus moscheutos	Rose Mallow
Lythrum salicaria	Purple Loosestrife
Scrub/Shrub Wetland Behind Levee	
Cornus amomum	Silky Dogwood
Acer rubrum	Red Maple
Salix nigra	Black Willow
Lythrum salicaria	Purple Loosestrife
Forested Wetland Behind Levee	
Acer rubrum	Red Maple
Liquidambar styraciflua	Sweet Gum
Salix nigra	Black Willow
Gleditsia tricanthos	Honey Locust
Platanus occidentalis	Sycamore
Cornus amomum	Silky Dogwood
Quercus palustris	Pin Oak
Tidal Wetlands Along Raccoon Creek	
Zizania gigantica	Wild Rice
Phragmites australis	Phragmites
Typha latifolia	Broad-leaved cattail
Typha angustifolia	Narrow-leaved cattail
Hibiscus moscheutos	Rose Mallow
Pontederia cordata	Pickerelweed
Peltandra virginica	Arrow arum
Nuphar advena	Spatterdock
Sagittaria latifolia	Broad-leaved Arrowhead
Impatiens capensis	Jewelweed
Cornus Amomum	Silky Dogwood
Cephalanthus occidentalis	Buttonbush

Source: Timothy Dunne. 1996. Written Communication

Table 7
Threatened and Endangered Species of Wildlife Found in Wetlands Near Repaupo Creek, Gloucester County, New Jersey

Species	Status	Habitat	Critical Season
Shortnose Sturgeon	Federal Endangered State Endangered	Delaware River	March-June
Bog Turtle	Federal Candidate State Endangered	Sedge meadows Emerging wetlands with good water quality	April-July
Wood Turtle	State Threatened	Forested wetlands with good water quality	April-July 15
Bald Eagle	Fed. Endangered State Endangered	Rivers, creeks, wetlands	Feb. 1 - July 1
Peregrine Falcon	Fed. Endangered State Endangered	Wetlands, rivers, creeks	None in Repaupo Not breeding here
Cooper's Hawk	State Endangered	Woodlands	April 1-June 15
Red-Shouldered Hawk	State Endangered	Forested wetlands	March 15-May 15
Barred Owl	State Threatened	Forested wetlands	Feb. 15-April 15
Henslow's Sparrow	State Endangered	Brushy marsh edges	May-Sept

Source: Notable Information on New Jersey Animals Database. New Jersey Division of Fish, Game and Wildlife. 1996.

Alternative 2 - Replace Existing Tidegate

This alternative would create a limited, temporary disturbance in the vicinity of the tidegate on Repaupo Creek. A small amount (less than 1/4 acre) of wetlands may need to be filled to replace the structure and meet current specifications.

There would be no significant changes to the 1,000 acre wetland between Route 44 and the levee on the Delaware River.

Construction could be scheduled to lessen the temporary impacts to wildlife. Critical breeding/nesting/spawning seasons should be avoided.

A fish ladder could be installed with the new tidegate to reestablish the extinct Clupeid spawning run in the Repaupo Creek. This would significantly increase the cost to the project but several potential partners have expressed interest in fish ladder installation (PSE&G, NJ Division of Fish, Game and Wildlife).

Alternative 3 - Rebuild Levee and Tidegate

This alternative would increase the levee footprint and result in loss of wetlands adjacent to the existing levee. Exact wetland acreage lost cannot be determined until engineering plans are completed. In addition this alternative would probably have a significantly longer construction schedule and the temporary disturbance to local fisheries and wildlife would be increased.

As with alternatives 1 and 2, construction could be scheduled to reduce temporary impacts to fish and wildlife. Critical breeding/nesting/spawning season should be avoided. Also there would be no significant changes to the 1,000 acre wetland between Route 44 and the Delaware River. A fish ladder, similar to Alternative 2, could be installed with the new tidegate to reestablish the extinct Clupeid spawning run in the Repaupo Creek. This would be a significant increase in cost of the project but several potential partners have expressed an interest in fish ladder installation (PSE&G, NJ Division of Fish, Game & Wildlife).

Alternative 4 - Levee Enhancement and Replacement of Existing Tidegate (Combination Alternative 1 and 2).

This alternative would increase the size of the existing levee. Some wetlands would be filled to expedite the footprint of the levee. Exact wetland acreage lost cannot be determined until engineering plans are completed. There would be a loss of existing wetland vegetation and wildlife habitat where this fill occurs. Other impacts to local fisheries and wildlife would be

temporary in nature during the construction phase of the project. There would be no significant changes to the 1,000 acre wetland between Route 44 and the Delaware River.

The impact of the small amount of wetland lost to fill along the levee could be mitigated by wetland restoration in the Repaupo watershed upstream. Construction could be scheduled to reduce the temporary impacts to fish and wildlife. Critical breeding/nesting/spawning seasons should be avoided.

This alternative would create a limited, temporary disturbance in the vicinity of the tidegate on Repaupo Creek. A small amount (less than 1/4 acre) of wetlands may need to be filled to replace the structure and meet current specifications.

A fish ladder could be installed with the new tidegate to reestablish the extinct Clupeid spawning run in the Repaupo Creek. This would be a significant increase in cost to the project but several potential partners have expressed interest in fish ladder installation (PSE&G, NJ Division of Fish, Game and Wildlife).

Habitat for species dependent on non-tidal freshwater wetlands such as bog turtle, wood turtle, red shouldered hawk and barred owl would be protected with implementation of Alternatives 1 - 4.

Alternative 5 - Relocation of Levee and Tidegate to Route 44

This alternative involves abandonment (or removal) of the existing levee along the Delaware River and relocating it at Route 44. This is also an extensive project that would have longer temporary impacts to fisheries and wildlife than alternatives 1 and 3. Relocation of the levee would include fill of some wetlands along Route 44. The exact wetland acreage lost cannot be determined until engineering plans are completed. There would be a loss of existing wetland vegetation and wildlife habitat where this fill occurs. That loss, however, would be mitigated by the restoration of the more than 1,000 acres of formerly farmed areas to tidal wetlands. Most of the ditched, abandoned farmland between Route 44 and the Delaware River would be subject to daily tidal flooding from the Delaware and Repaupo Creek. The water level would rise and significant changes would occur to wetland vegetation and wildlife habitat. The forested and scrub/shrub wetlands would decrease in size and be restored to emergent wetlands similar to those along Raccoon Creek, about two miles south of Repaupo Creek. Table 6 lists dominant plant species found in the tidal wetlands. Care would have to be taken to protect the restored area from invasion of purple loosestrife and Phragmites.

Effects on wildlife could be significant. Species adapted to forested and scrub/shrub wetlands may decline and species adapted

to the tidal wetlands should increase. Habitat for threatened and endangered species dependent on non-tidal freshwater wetlands such as the bog turtle, wood turtle, red shouldered hawk and barred owl would decrease under Alternative 5. Habitat for bald eagle and peregrin falcon would increase. Overall there is a shortage of the tidal wetlands along the Delaware due to levee construction, development and spoil disposal areas. A 1,000 acre restoration of tidal wetlands would benefit the Delaware River ecosystem in southern New Jersey.

Clupeid spawning runs would be reestablished to the lower Repaupo Creek with this alternative and could be restored farther upstream with installation of a fish ladder at the new tidegate locations along Route 44.

Alternative 6 - Total Buyout

This alternative would also result in abandonment of the Delaware River levee and Repaupo Creek tidegate. A similar restoration of tidal wetlands for the 1,000 acre area between Route 44 and the Delaware River could occur. Some areas upstream of Route 44 also will be affected by daily tidal flooding. Perhaps another 300-400 acres would be subject to daily tidal flooding and could be restored. Similar changes to wetland vegetation and wildlife would occur as in Alternative 5.

Clupeid spawning runs would be reestablished to Repaupo Creek.

Cultural Resources Evaluation

Where federal funding is used, any alternative which impacts on a significant cultural resource must be mitigated. These costs are generally the local sponsors responsibility. Archaeological sites are identified and listed on the National Register of Historic Places. The National Register of Historic Places shows a structure on Paulsboro-Swedesboro Road, however, this structure does not appear to be at risk of being impacted by any of the alternatives. There are also five known sites in close proximity to what may become the work limits of several alternatives. It is unknown at this time whether these five sites are on the National Register of Historic Places. In the final analysis, the work limits of the project must be defined in order to perform a complete cultural resources evaluation.

Potential for Further NRCS Assistance

Questions regarding the Corps of Engineers and New Jersey Department of Environmental Protection jurisdiction and interest in this project need to be resolved. NRCS, to the best of our knowledge, is unable at this time to do any work on the levee under terms of a 1962 letter (Thorpe, 1962) and national policy which requires that we work in watersheds of 250,000 acres or less. A waiver of this policy or new agreement between the Corps and NRCS would be needed to work on the levee portion.

There does appear to be sufficient justification for proceeding with development of a supplement to the Repaupo Creek Watershed Work Plan, based on the data collected for this report and the preliminary alternatives outlined. However, any further commitment of time and resources by the Natural Resources Conservation Service to this project beyond this current report is dependent on resolution of the ownership issue as well as a local commitment for the project construction and future operation, maintenance and replacement of any works of improvement.

All PL-566 projects must be sponsored by one or more local organizations qualifying as a sponsoring local organization (SLO). The SLO of a project must have the power of eminent domain so that they may acquire real property or water rights needed for the project (USDA, 1992). They must also have authority to levy taxes or another adequate means of financing their share of the cost of the project as well as operation, maintenance and replacement expenses (USDA, 1992). The local commitment should take the form of a letter from those willing to be the sponsor (s) to the Natural Resources Conservation Service showing that they will use their powers and authority to ensure the installation, operation, maintenance and replacement of the project as planned.

Following resolution of the ownership issue and a formal commitment for sponsorship, the sponsor (s) need to be aware that high priority for Natural Resource Conservation Service PL-566 funding for projects will occur when:

1. The primary solution to the resource problem can be accomplished using non-structural and land treatment measures.

2. The principle water resource problem being addressed is water quality and/or water conservation that will benefit fish and wildlife or other environmental concerns.

3. Wildlife, wetland acquisition, preservation and/or enhancement are an integral part of the project.

4. The project will provide significant benefits to socially and economically disadvantaged groups.

5. A large portion of the project installation will be funded by other than PL83-566 funds (USDA, 1994).

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